Wearable human body falling detection device

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Abstract—This study on the utilization of parameters focuses on detecting the human body falling. A sensor detects a three-axes acceleration distribution pattern to determine whether a fall has taken place and to judge whether the subject returns to normal behavior after falling in order to determine whether the function of timely notification is needed, and to reduce the consumption of social resources due to misjudgment.

Keywords: fall detection, wearable device

I. INTRODUCTION

According to the U.S. Centers for Disease Control and Prevention, one in four Americans aged 65+ falls each year. Falls are the leading cause of fatal injury and the most common cause of nonfatal trauma-related hospital admissions among older adults. There were 10,273 deaths in 2000 and 25,464 in 2013 from unintentional falls among adults aged ≥65. Falls result in more than 2.8 million injuries being treated in emergency departments annually, including more than 800,000 hospitalizations and more than 27,000 deaths. In 2014, the total cost of fall injuries was $31 billion. The financial toll for older-adult falls is expected to increase as the population ages and may reach $67.7 billion by 2020 [1][2], so the expansion of healthcare via science and technology will be endless. In the era of informatization, wearable devices will become indispensable medical equipment. Individuals can use wearable devices that incorporate their required medical equipment. Accuracy of fall detection methods and devices is important because getting help quickly after a fall reduces the need for hospitalization by 26% and the risk of death by more than 80% [3]. Support Vector Machine (SVM) methods can be used to predict fall events. However, the accuracy and timeliness have not been mentioned. The angle errors calculated from tri-axial acceleration may be one of the reasons for misdetection of the accelerometer-based detection system, since the system’s outputs consist of not only body accelerations but also gravity. Additionally, the acceleration information for one instance is not sufficient to describe human motions. This experimental structure increases the behavior of judging the fall, reduces the large swing motion in daily life and reduces misjudgment and falls, reducing the cost of social resources.

II. SYSTEM DESIGN

A. Accelerometer

The ADXL335 is a small, thin, low power, complete 3-axes accelerometer with signal-conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

B. Wearable device

The rapid development of science and technology has led to wearable devices prevailing over traditional techniques. Such wearable devices are the focus of this study. Newly designed light, handy and fashionable wearable devices can now incorporate a software program that increases the functions of the wearable device. A fall alarm can be added to the basic functions, and future functions can be increased to include determining heartbeat, and reducing the occurrence of accidents by providing physiological information.

C. The process through which the accelerometer detects the fall Signal Vector Magnitude

With the acceleration of the X-axis, Y-axis or Z-axis, the vector norm of the three-axes acceleration value is taken as the SVM value. When the X-axis or Y-axis or Z-axis value is greater than 2G, a fall event is determined to have occurred. The formula is as follows:

\[(|\alpha_x| > 2 \text{ or } |\alpha_y| > 2 \text{ or } |\alpha_z| > 2) = M \]

\[M = \text{true}\]

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III. RESULTS AND DISCUSSIONS

A. Research equipment

This study sets out to record the ADXL335 three-axes acceleration value for falls. In combination with the Arduino, the signal readout is transmitted to the linking device in a timely manner. The system also determines whether normal behavioral movements follow the fall. In contrast to other devices that use only violent shaking in judging the behavior of falling, this effectively improves the accuracy of judging the fall.

B. Research Tester

Tester places the wearable device on the belt and tests the fall behavior. Implementation time: 20 seconds.

C. Experiment steps

Start the three-axes accelerometer, and instantly determine whether the three-axes system has detected a >= 2G signal and determine whether there is a need to call for help after confirming the fall.
apparent movement, he will immediately judge the occurrence of the accident and notify the first-aid contact.

We can make use of existing equipment to combine software and the detection and prevention of accidents. Furthermore, the aforementioned system for determining fall risk includes a smart phone that can receive signals and send an emergency message.

![Figure 6. The model of fall behavior combined with wearable devices.](image)

IV. CONCLUSION

So far, using vibration to judge a falling system is about 70% to 80% accurate, so the accuracy can be further increased by adding confirmation of the behavior after the falling down occurs. If users are female, they may prefer a design that is more delicate and easy to carry and that combines aesthetics with function. If the place of use is a bathroom, the device needs to be waterproof and have increased battery storage.

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REFERENCES

[1] International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10)